3.8. The River Danube Water Quality nearby Novi Sad as Affected by Changes in River Water Flows

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3.8.1. Introduction

Continual investigations of the river Danube water quality in the Institute of Biology (Faculty of Science in Novi Sad) last already 25 years. Our published results (Gayin *et al.*, 1982, 1984, 1987, Matavuly *et al.*, 1988) point to the various quality of the Danube water at the Novi Sad sector, with the tendency of decrease of water quality after 1979 and the slight increase of water quality after 1989 (Gayin *et al.*, 1990, 1995). Supported by Novi Sad City Authorities for the environmental protection and conservation, investigations with 11 sampling sites at the Novi Sad sector have been organized in the course of 1998-1999. Since the river Danube waterbed has been used as the main source of Novi Sad potable water, and in the same time the river water has been serving as the main recipient of municipal sewage water, results of current sapromicrobiological investigations should point to the effect of main city polluters on the river water quality, as well as to the effect of destruction of all three bridges over the river Danube in Novi Sad.

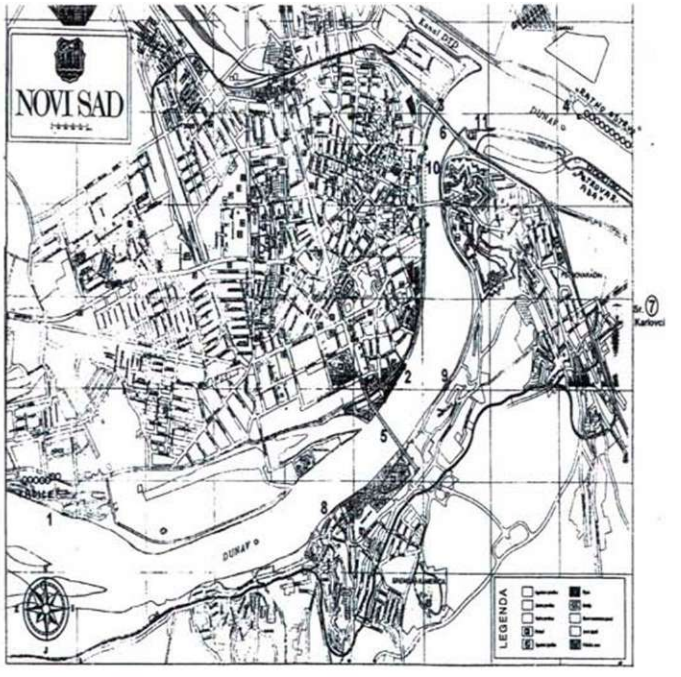

Fig. 1. Novi Sad City map with sampling sites

3.8.2. MATERIAL AND METHODS

Samplings of the river Danube water in the Novi Sad region were done seasonally during 1998 (prewar period) and during 1999 (postwar period). Sampling sites are shown at fig. 1. 11 localities (left river bank: 1 Kamenyar, 2 Shtrand, 3 Railway bridge, 4 Pover plant; main river current: 5 Freedom bridge, 6 between Petrovaradin and Railway bridges, 7 Sremski Karlovci; right river bank: 8 Sremska Kamenica, 9 Ribnyak, 10 Petrovaradin, 11 Oficirska plazha) have been chosen with aim to illustrate the influence of the main Novi Sad City polluters on the river Danube water quality from the sapromicrobiological and enzymological point of view.

The mesophilic saprophytic bacteria were enumerated at the nutrient agar. The number of facultative oligotrophs has been determined at 10 times diluted nutrient agar. The number of colony forming units was used for the river Danube water categorization into classes of quality according to Kohl (1975).

The relationship between heterotrophs, originating from eutrophic environments, and facultative oligotrophs, originating from oligotrophic environments, defined as H/FO ratio was used for determination of the water selfpurification ability (Gayin *et al.*, 1990). Enzyme, phosphatase activity of nontreated water sample has been determined using p-Nitrophenylphosphate as a substrate and Phosphatase activity index (PAI) was calculated as a mean value of acid, neutral and alkaline phosphatase activity of water, and used for categorization of water into classes according to Matavuly (1986).

3.8.3. RESULTS AND DISCUSSION

The results obtained by enumeration of organotrophic bacterioplankton point to the various water quality depending on the locality, as well as to the seasonal fluctuating in the quality of water considering its organic load. As a rule, the lowest number of heterotrophs, as well as facultative oligotrophs, was recorded in the spring season and the highest during the summer-autumn seasons in the course of 1998, what was in agreement with our previous reports. The lowest number of heterotrophs at the most sampling sites in summer or autumn season during 1999, except at the locality No 3 (downstream of destroyed railway bridge), disagreed with our previous findings of bacterial seasonal fluctuations in the river Danube water (Gayin *et al.*, 1995), probably due to changed conditions considering organic load caused by changed flow of sewage water.

The ratio between the number of facultative oligotrophic and heterotrophic bacterioplankton (FO/H index, Gayin *et al.*, 1990, 1993) point to the preserved selfpurification ability and high rate of degradation of pollution downstream of Novi Sad sewage effluent, especially during warm seasons. The exception of this rule was localities downstream of sewage effluent during 1998 (Fig. 2, localities 3 and 4).

Huge amount of building material that has plunged into the riverbed due to Novi Sad bridges destruction by NATO bombardment has drastically changed the course of main current of the river Danube, as well as the bank water currents. Consequently, the course of municipal wastewater has been changed, what caused the changes in the river Danube water quality considering the river water horizontal profiles. These changes are the most noticeable downstream of the destroyed railway (Zhezhely's) bridge (sampling site No 3,

Fig. 1). In the course of prewar period (1998) the highest water pollution according to sapromicrobiological and enzymological indicators has been recorded at this locality, caused by the nearby effluent of Novi Sad municipal water (Fig. 2, Fig. 3). According to the same parameters, the river Danube water quality at the same locality, after the fall of railway bridge has substantially changed, because the municipal water stream has been shifted from the bank current to the main river stream. The same effect has been recorded at the sampling site No 4, downstream of Novi Sad oil refinery. In the course of prewar period this locality was the second, considering the organic pollutants load (Fig. 2, Fig. 6). After turning the municipal water into the main river stream due to destruction of all three bridges, the water quality at this locality shifted from III to II-III class according to Kohl (1975), (Fig. 4, Fig. 7). Such a findings were confirmed by the Phosphatase activity index. According to this parameter, the water downstream of main sewage effluent in 1998 belonged to IIIA class in the spring and summer seasons (significantly polluted water

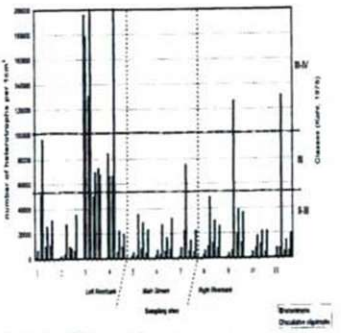

Figure 2 The River Danube water quality nearby Novi Sad during 1998 according to the number of organotrophs (spring, summer, autumn and winter)

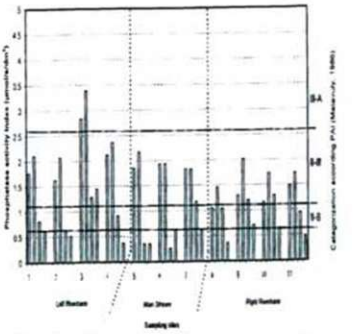

Figure 3 The River Danube water quality nearby Novi Sad during 1998 according to the phosphathase activity index (PAI) (spring, summer, autumn and winter)

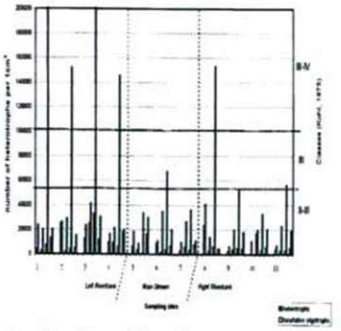

Figure 4 The River Danube water quality nerby Novi Sad during 1999 according to the number of organotrophs (spring, summer, autumn and winter)

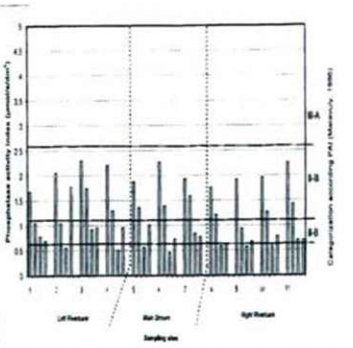

Figure 5 The River Danube water quality nearby Novi Sad during 1999 according to the phosphathase activity index (PAI) (spring, summer, autumn and winter)

according to Matavuly, 1986) (Fig 3). In 1999 the water sampled at the same locality increased in quality one class higher (Fig 5) due to turning the sewage water from coastal

into main Danube stream. Even though the lowest water quality was found downstream of Novi Sad sewage effluent (site 3) during both one year prewar as well as postwar period, it is noticeable that at the same site after forming a dam made of destroyed concrete railway bridge the coastal stream of the river flows about 100 m in opposite direction than the main river stream flows.

According to sapromicrobiological and enzymological indicators, the water of the river Danube at the most localities nearby Novi Sad belonged to II class (Kohl, 1975) and to II-III class - moderately polluted (Matavuly, 1986) respectively. Expectedly, the lowest water quality downstream of the main sewage effluent was recorded during both, 1998 and 1999 years of investigation. Destruction of all of three Novi Sad bridges over the river Danube by NATO bombardment, and formation of dam of huge amount of building material that has fallen down into the riverbed caused changes of the river coastal streams as well as mainstream. Consequently, the stream of sewage effluent changed its direction from coastal current to the main river stream, what caused changes in the river water quality downstream of new formed dam in Novi Sad.

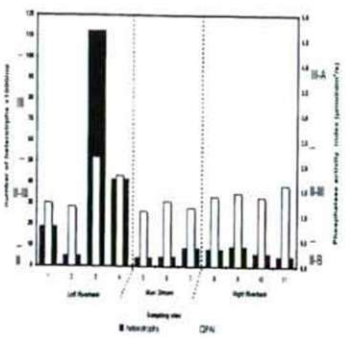

Figure 6 The River Danube water qualities nearby Novi Sad during 1998 (mean values)

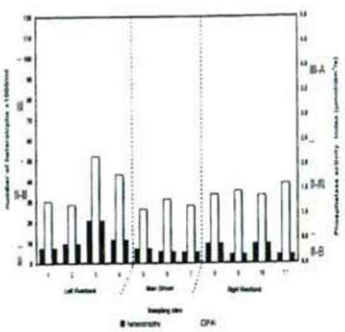

Figure 7 The River Danube water qualities nearby Novi Sad during 1999 (mean values)

3.8.4. SUMMARY

Continual investigations of the river Danube water quality in the Institute of Biology (Faculty of Science in Novi Sad) last already 25 years. Since the river Danube waterbed has been used as the main source of Novi Sad potable water, and in the same time the river water has been serving as the main recipient of municipal sewage water, results of current sapromicrobiological investigations should point to the effect of main city polluters on the river water quality, as well as to the effect of destroying of all three bridges over the river Danube in Novi Sad. Obtained results point to the preserved selfpurification ability and high rate of degradation of organic load downstream of sewage effluent. Also, huge amount of building material that has plunged into the riverbed due to Novi Sad bridges destruction by NATO bombardment has drastically changed the course of main current of the river Danube, as well as the bank water currents. Consequently, the course of municipal wastewater has been changed, what caused the changes in the river Danube water quality considering the river water horizontal profiles.

3.8.5. REFERENCES

Gayin, S., Petrovicy, O., Matavuly, M., Gantar, M. (1982): Die Bewertung der Wasserqualität der jugoslawischen Donaustrecke aufgrund einiger mikrobiologischer Parameter. – Proc. 23. Arbeitstagung der IAD, Wien, 62-64 pp.

Gayin, S., Gantar, M., Petrovicy, O. (1984): Microbiological indicators of the river Danube water quality. – Vodoprivreda, 16, 88-98 (2-3), 91-94.

Gayin, S., Matavuly, M., Petrovicy, O., Gantar, M., Obreht, Z. (1987): Ergebnisse mikrobiologischer Untersuchungen des Donauwassers im jugoslawischen Flussabschnitt. – Proc. 26. Arbeitstagung der IAD, Passau, 481-484 pp.

Gayin, S., Gantar, M., Matavuly, M., Petrovicy, O. (1990): The long-term investigation of the river Danube water quality in the Yugoslav section according to microbiological parameters. - Wat. Sci. Tech., 22, 5, 39-44.

Gayin, S., Petrovicy, O., Radnovicy, D., Obreht, Z., Matavuly, M. (1993): The influence of Novi Sad City on the river Danube water condition. - Proc. Yug. Conf. "Water Protect. '93": 167-171 pp (in Serbian, English abstract).

Gayin, S., Petrovicy, O., Matavuly, M., Radnovicy, D., Obreht, Z. (1995): Microbiological-biochemical indicators of the river Danube water quality nearby the Novi Sad City. Proc. "Eco-Conference '95", Novi Sad, 87-94 pp (in Serbian, English abstract).

Gayin, S., Matavuly, M., Petrovicy, O., Radnovicy, D. (1999): The effect of pollutants from the Novi Sad region to the river Danube water quality in the one-year prewar period. - Proc., Eco-conference '99 ", Novi Sad, 201-206 pp. (in Serbian, English abstract).

Kohl, W. (1975): Über die Bedeutung Bakteriologischer Untersuchungen für die Beurteilung von Fleissgewassern, Dargestellt am Beispiel der Österreich. - Donau. Arch. Hydrobiol., 44, 4, 392-461.

Leifson, E. (1963): Determination of Carbohydrate Metabolism of marine Bacteria. - J. Bacteriol., 85, 1183-1184.

Matavuly, M., (1986): Nonspecific phosphomonoester-hydrolases of microorganisms and their importance in the phosphorus cycle in the aquatic environments. - PhD Thesis, Faculty of Science, University of Zagreb (in Serbian, English Summary).

Matavuly, M., Bokorov, M., Stoyilkovicy, S., Gayin, S., Gantar, M., Erbezhnik, M., Petrovicy, O. (1988): Enzyme activity of water as a monitoring parameter. - Proc. Yug. Conf. "Water Protection '88",, 182-192 pp (In Serbian, English abstract).

Matavuly, M., Bokorov, M., Gayin, S., Gantar, M., Stoyilkovicy, S., Flint K.P. (1990): Phosphatase activity of water as a monitoring parameter. - Water Science and Technology, 22, 5, 63-68.

Matavuly, M., Gayin, S., Erbezhnik, M., Bokorov, M., Petrovicy, O. (1989): Phosphatase activity of water as a parameter of the river Tisza water monitooring. - Tiscia (Szeged), 23, 29-36.

Norris, J.A., Ribbons, D.W. (1971): Methods in microbiology. - Vol. 6A. Academic Press. London - New York.

Petrovicy, O., Gayin, S., Matavuly, M., Radnovicy,D. Svirchev, Z. (1998): Microbiological investigations of the surface water quality. Institute of Biology, Faculty of Science, University of Novi Sad.